NASA Carbon Monitoring System Applications Workshop Welcome

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Pasadena, CA

http://www.carbon.nasa.gov

Congressional Direction (Summary)

Congressional Direction in 2010:

Also included within the funds provided for other mission and data analysis, the conference agreement provides $6,000,000 for pre-phase A and pilot initiatives for the development of a carbon monitoring system. Any pilot developed shall replicate state and national carbon and biomass inventory processes that provide statistical precision and accuracy with geospatially explicit associated attribute data for aggregation at the project, county, state and federal level using a common dataset with complete market transparency, including extraction algorithms and correlation modeling.

Congressional Direction in 2011:

None

Congressional Direction in 2012:

The Committee recommends $10,000,000 from within available funds to continue the development of a carbon monitoring system initially funded in fiscal year 2010. The Committee expects no less than one-half of this amount shall be awarded externally.

Language in Senate Draft for 2013:

Of the funds provided within the earth science research and analysis activity, the Committee recommends $10,000,000 to continue efforts for the development of a carbon monitoring system initially funded in fiscal year 2010. The majority of the funds should be directed towards acquisition, field sampling, quantification and development of a prototype Monitoring Reporting and Verification [MRV] system which can provide transparent data products achieving levels of precision and accuracy required by current carbon trading protocols. The Committee recognizes that the current orbital and suborbital platforms are insufficient to meet these objectives. Therefore, the use of commercial off-the-shelf technologies is recommended as these products could provide robust calibration validation datasets for future NASA missions. Up to 20 percent of these funds should be made available to international Reducing Emissions from Deforestation and Forest Degradation [REDD] projects. Furthermore, the Committee is deeply disappointed with the lack of progress that NASA has made on this initiative thus far within the agency. Therefore, it directs that the above funds shall be competitively awarded within 120 days of enactment of this act.

Congressional Direction in 2014:

Carbon Monitoring- Of the funds provided within the Earth Science research and analysis activity, the Committee recommends $10,000,000 to continue efforts for the development of a carbon monitoring system. The majority of the funds should be directed toward acquisition, field sampling, quantification, and development of a prototype Monitoring Reporting and Verification [MRV] system which can provide transparent data products achieving levels of precision and accuracy required by current carbon trading protocols. The Committee is concerned that NASA has not established a program of record around the development of MRV system, and therefore expects a plan from NASA not later than 90 days after enactment of this act incorporating such a system into its operating plan and long-term budget projection. The Committee recognizes that the current orbital and suborbital platforms are insufficient to meet these objectives. Therefore, the use of commercial off-the-shelf technologies is recommended as these products could provide robust calibration validation datasets for future NASA missions.

…"pilot initiatives for the development of a carbon monitoring system…"

…"replicate state and national carbon and biomass inventory processes that provide statistical precision and accuracy with geospatially explicit associated attribute data…"

…"development of a prototype Monitoring Reporting and Verification (MRV) system which can provide transparent data products achieving levels of precision and accuracy required by current carbon trading protocols…."

…"[development of] a plan…incorporating such a [MRV] system into its operating plan and long-term budget projection…"

NASA-CMS Phase 1

Biomass Pilot. *The goals of the Biomass Pilot are to:*

- Utilize satellite and in situ data to produce quantitative estimates (and uncertainties) of aboveground terrestrial vegetation biomass on a national and local scale.
- Assess the ability of these results to meet the nations need for monitoring carbon storage/sequestration.

Flux Pilot. *The objectives of the Flux Pilot are to:*

- Combine satellite data with modeled atmospheric transport initiated by observationally-constrained terrestrial and oceanic models to tie the atmospheric observations to surface exchange processes.
- Estimate the atmosphere-biosphere CO_2 exchange.

Scoping Efforts. *The objectives of the Scoping Efforts are to:*

- Identify research, products, and analysis system evolutions required to support carbon policy and management as global observing capability increases.

NASA-CMS Phase 2

CMS Award year: # of projects (decision support - MRV)

2012: 20
2013: 17
2014: 15

Global Surface-Atmosphere Flux

2012: 2
2014: 3 (2)

Land-Atmosphere Flux

2012: 6 (5)
2013: 8 (6)
2014: 2 (2)

Ocean-Atmosphere Flux

2012: 1

Ocean Biomass

2012: 3

Land-Ocean Flux

2012: 1
2014: 1 (1)

Land Biomass

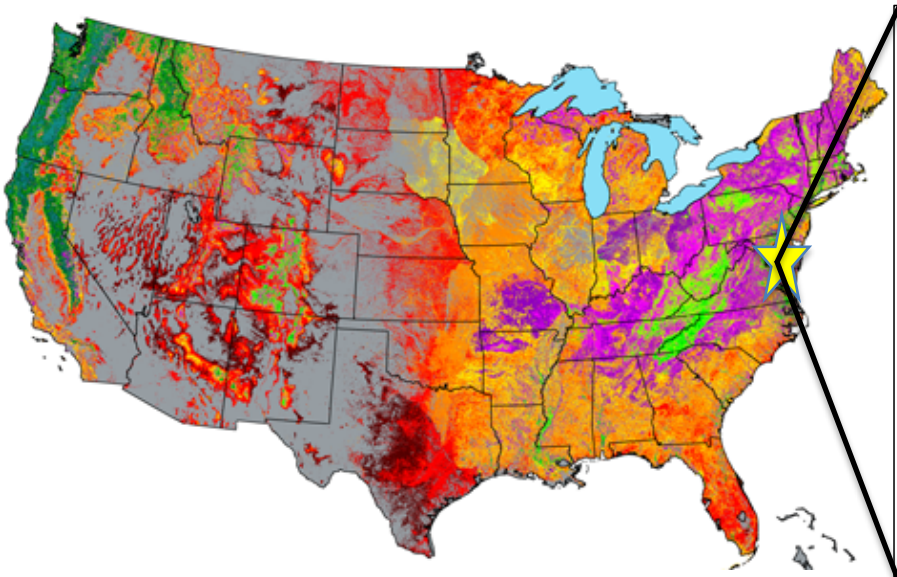
2012: 7 (5)
2013: 9 (9)
2014: 9 (7)

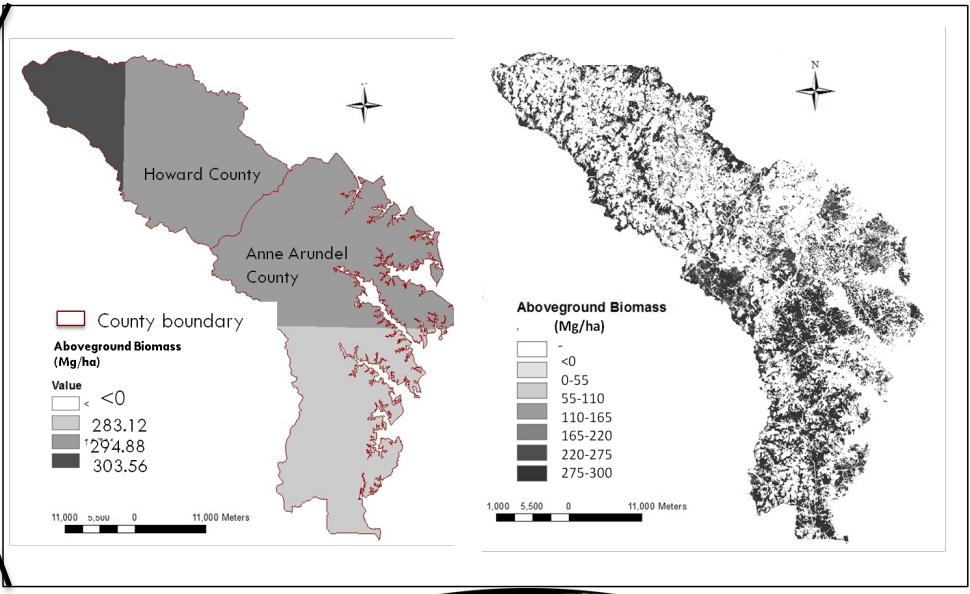
Participants By Type and By Country

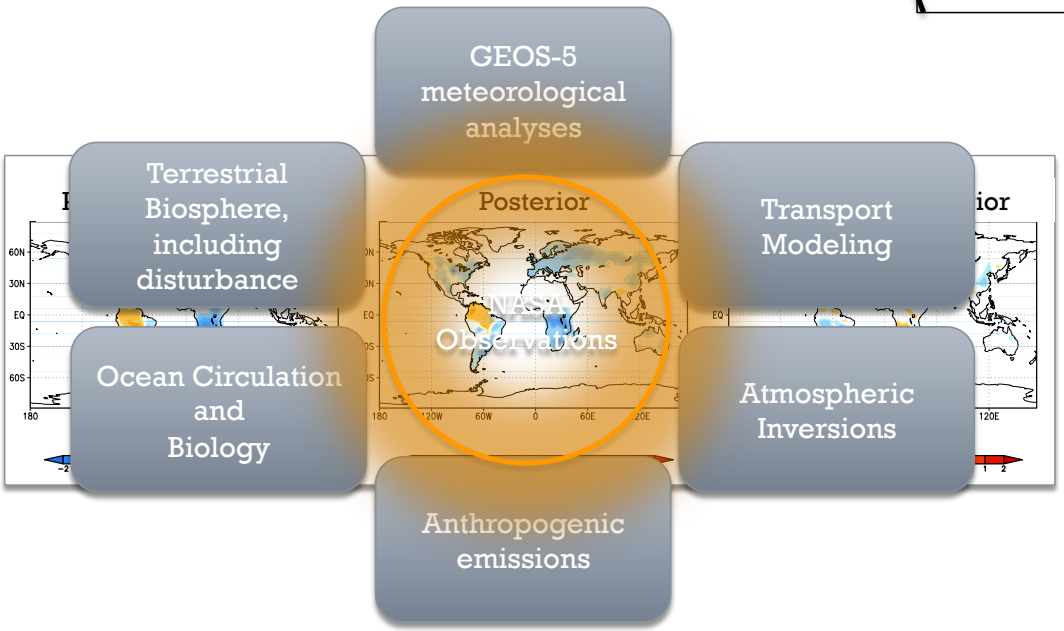
ORG TYPE (# unique)	US	MX	Brazil	UK	Total
University (35)	60	3	1	1	65
National Agencies/Labs (8)	62	1			63
State (1)	3				3
Private (12)	14				14
Research Center (2)	6	1			7
NGO (4)	4		1		5
Total	**149**	**5**	**2**	**1**	**157**

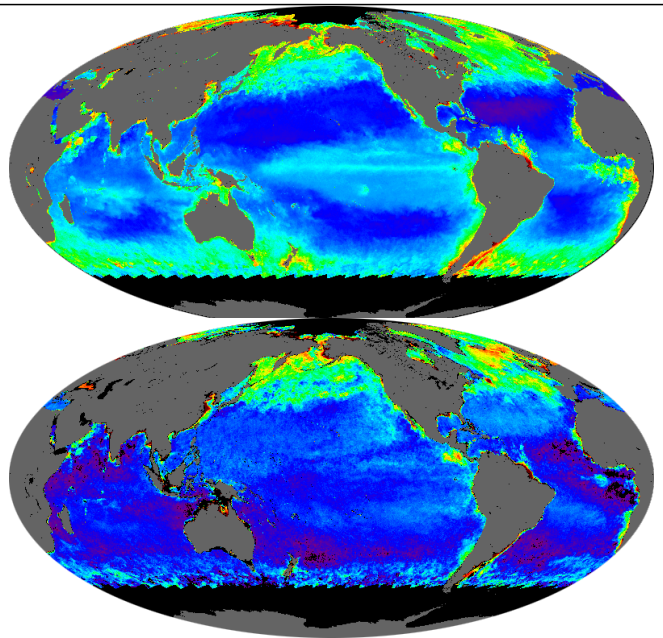
U.S. Agencies and Organizations

Federal	State	NGO	Private
NASA	CA Air Resources Board	Global Forest Watch	AER, Inc
NOAA		Resources for the Future	Applied Geosolutions
USDA FS	**US Research**	Winrock Intl.	Earth Networks
DOE	Woods Hole Research Center		Geodigital Intl Corp.
USGS			RHG
EPA			Neptune, Inc.
Dept. of State			Sigma Space Corp.
			Watershed Sciences Inc.
		I	4 Consultants




Howard County
Anne Arundel County
County boundary
Aboveground Biomass (Mg/ha)
Value
<0
283.12
294.88
303.56
11,000 5,500 0 11,000 Meters
N
Aboveground Biomass (Mg/ha)
<0
0-55
55-110
110-165
165-220
220-275
275-300
1,000 5,500 0 11,000 Meters

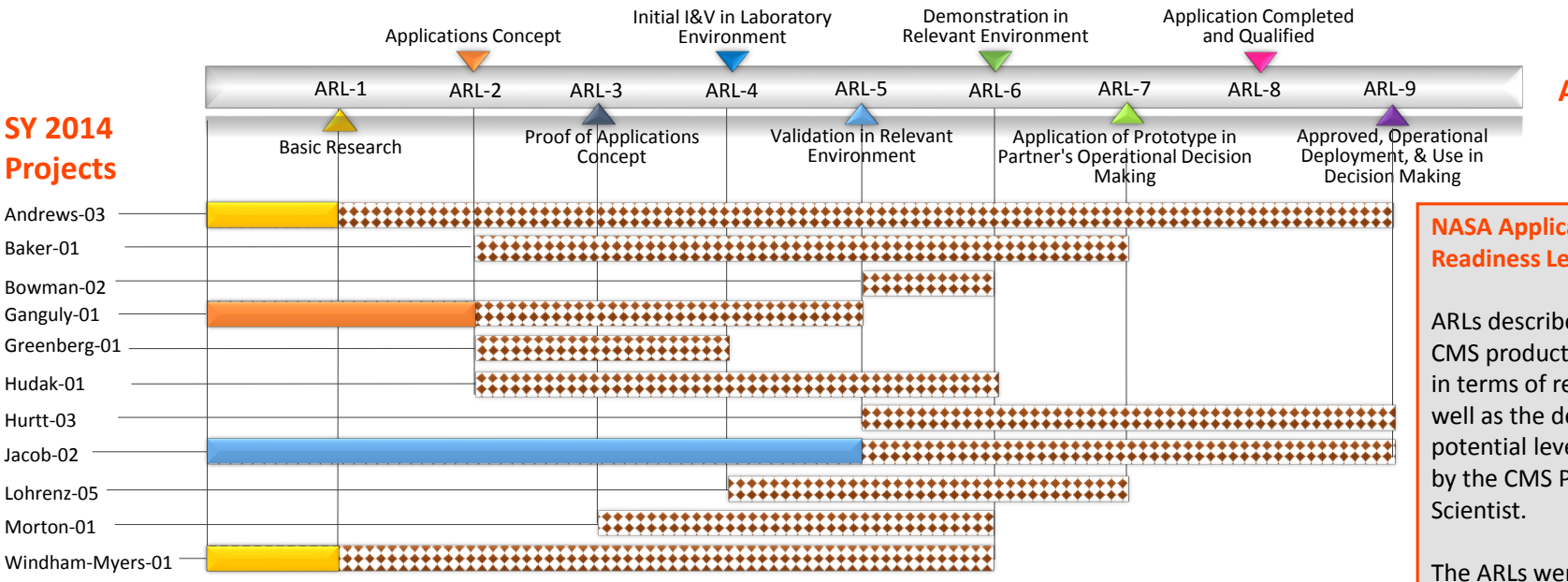

GEOS-5 meteorological analyses
Terrestrial Biosphere, including disturbance
Transport Modeling
Posterior
NASA Observations
Ocean Circulation and Biology
Atmospheric Inversions
Anthropogenic emissions



- 140 unique publications (papers, book chapters)
  - 7 publications in Nature, Science and PNAS including two currently on the NACP Citations Classics list with over 100 citations

- Baccini, A., S.J. Goetz, W.S. Walker, N.T. Laporte, M. Sun, D. Sulla-Menashe, J. Hackler, P.S.A. Beck, R. Dubayah, M.A. Friedl, S. Samanta, and R.A. Houghton. 2012. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. Nature Climate Change (Houghton-02) NACP Citation Classic with 191 Citations
- Cai, W.-J., X. Hu, W.-J. Huang, M. C. Murrell, J. C. Lehrter, S. E. Lohrenz, W.-C. Chou, W. Zhai, J. T. Hollibaugh, Y. Wang, P. Zhao, X. Guo, K. Gundersen, M. Dai and G.-C. Gong (2011). 'Acidification of subsurface coastal waters enhanced by eutrophication.' Nature Geosci (*Lohrenz-03*) 116 citations (to be added to NACP classics)
- Erb, K.-H., T. Kastner, S. Luyssaert, R.A. Houghton, T. Kuemmerle, P. Olofsson, and H. Haberl. 2013. Bias in the attribution of forest carbon sinks. Nature Climate Change (*Houghton-02*) *commentary*
- Gately, C. K., L. R. Hutyra, and I. S. Wing, 2015: Cities, traffic, and CO2: A multidecadal assessment of trends, drivers, and scaling relationships. Proceed. National Academy Sci. (*Nehrkorn-01*)
- McKain, K., A. Down, S. M. Raciti, J. Budney, L. R. Hutyra, C. Floerchinger, S. C. Herndon, T. Nehrkorn, M. Zahniser, R. B. Jackson, N. Phillips, and S. C. Wofsy, 2015: Methane emissions from natural gas infrastructure and use in the urban region of Boston, Massachusetts. Proceed. National Academy Sci. (*Nehrkorn-01*
- Pan, Y., R.A. Birdsey, J. Fang, R. Houghton, P.E. Kauppi, W.A. Kurz, O.L. Phillips, A. Shvidenko, S.L. Lewis, J.G. Canadell, P. Ciais, R.B. Jackson, S.W. Pacala, A.D. McGuire, S. Piao, A. Rautiainen, S. Sitch, and D. Hayes. 2011. A large and persistent carbon sink in the world's forests. Science (*Houghton-02*) NACP Citation Classic with 766 citations
- Zeng, N., F. Zhao, G.J. Collatz, E. Kalnay, R.J. Salawitch, T.O. West and L. Guanter. 2014. Agricultural Green Revolution as a driver of increasing atmospheric CO2 seasonal amplitude. Nature (*West-03*)

CMS Application Readiness Levels (ARLs)



Fatoyinbo-01
Ott-01
Walker-W-01
Williams-C-01

Different ARLs are provided for the products in these projects. Refer to individual corresponding charts describing the product ARLs.

Project ID
PI-Project # (Andrews-02)-Each CMS Project is represented by its color and identified by the PI on the project

Solid color: each solid bar is indicative of where the PI feels their project is NOW in terms of application readiness.
Pattern fill: indicates the level each PI is striving for and the application readiness level they feel their project can ultimately satisfy.
Gradient fill: indicates current level has not been reached fully.

NASA Application Readiness Levels (ARLs)

ARLs describe where the CMS product is currently in terms of readiness, as well as the desired and potential level as defined by the CMS Product Scientist.

The ARLs were provided by the CMS Product Scientist and represent the most accurate representation of the state of each product.

Products can start at any level. It is not expected they will start at ARL1 and end at ARL9.

CMS Products and Policy Support Examples

CMS PI and Project	Organization	Policy of Interest
Cook-01 Forest biomass	USDA Forest Service	USFS Forest Inventory and Analysis (FIA), SilvaCarbon, USDA Forest Service Experimental Forests & Ranges system
Dubayah-03 Canopy height and forest/non-forest maps-For Maryland **Dubayah-04** Canopy height and forest/non-forest maps for Sonoma County	Maryland Department of Natural Resources and Sonoma County CA	(03): FIA, Federal Land Policy and Management Act (FLPMA), Maryland Greenhouse Gas Emissions Reduction Act Plan, Maryland Climate Action Plan, Chesapeake Bay TMDL, Maryland Forest Preservation Act, Maryland No Net Forest Loss Act. (04): REDD+, Sonoma County initiatives, California Assembly Bill 32: Global Warming Solutions Act (CA-AB32), CAP
Duren-01-Applications **Escobar-01**-Applications	IPCC, Doha/Kyoto, NGHGI, CAA, US-India Green Partnership EPA, MD, DE and PA DNRs, Chesapeake Restoration Program, RGGI, EPA, Sonoma County Agriculture Conservation	Low-resolution MRV technology for Safe Drinking Water Act's Underground Injection Control program Workshops and Reporting for MD GHG planning, Sonoma County AB32, EPA GHG Inventory Reports, USGS 3DEP Program
Jacob-01, Jacob 02, Estimates of methane emission fluxes and Anthropogenic and natural methane emissions estimates	EPA	Global Climate Change and Clean Air Initiative of the US State Department, Global Methane Initiative of the US EPA, CAA, NGHGI, President Obama's Climate Action Plan (CAP), NALS

CMS Products and Policy Support, Examples Con't

CMS PI and Project	Organization	Policy of Interest
Fatoyinbo-01 Mangrove forest biomass estimates	Brazil	REDD+, Le Gabon Emergent, Gabon Forest Carbon Assessment, Silvacarbon, GEO-FCT
French-04 Maps of emissions from wildland fires	US Forestry	Wildland Fire Emissions Information System (WFEIS), Global Fire Data (GFED), BlueSky, CAA, NGHGI, FLPMA
Keller-01 Maps of spatially explicit associated uncertainties in stock changes	Brazil Land Management	US-Brazil Memorandum of Understanding on Climate Change, Brazilian Forest Code, REDD+, NFMS, SilvaCarbon, Sustainable Landscapes Program Brazil
Morton-01 and Morton-02 Maps of annual deforestation, forest degradation, Maps of carbon stocks with pixel level uncertainties	Brazil	REDD+, SilvaCarbon, Science Without Borders, Global Carbon Project, GFED FIA, FLPMA
Saatchi-02 Disturbance layers (time since disturbance, recovery rate, disturbance severity)	US Forestry	NGHGI, CAP, IPCC Good Practice Guidance for Land, Use, Land-Use Change, and Forestry (IPCC GPG), FIA, NFMS
West-03 Carbon release by livestock and humans	EPA	IPCC GPG, NASA FPP, NASA Carnegie Ames Stanford Approach (CASA) model, DOE Integrated Assessment program, US Farm Bill, CAP

NASA's Approach to CM/MRV

- Recognizes that a sustained, observationally-driven carbon monitoring system using remote sensing data has the potential to significantly improve the relevant information base for the U.S. and world;
- Recognizes multiple users, multiple scales, multiple quantities, and multiple frameworks for MRV (e.g. International, national and subnational, markets);
- Regonizes the importance of user engagement to be responsive to stakeholder needs;

The goal for NASA's CMS project is to prototype the development of carbon monitoring capabilities needed to support U.S. needs for MRV.

*NASA-CMS (2014) Progress Report

Applications Workshop Summary (2014)

- Excellent interaction and input from stakeholders working with NASA-CMS projects, across a range of spatial/policy scales (subnational, national, international, and ocean).
- Stakeholders very pleased and encouraged by CMS activities, emerging capabilities, and future potential
- CMS should not just about data products, but also about addressing policy relevant science questions
- Importance of baseline, monitoring, and projection/prediction, and attribution
- Importance of uncertainty quantification, “accuracy willing to pay for”
- Importance of state of art capability, leadership in CMS capabilities
- Input is timely, with very aggressive policy timelines nationally/internationally
- Need to get ahead in understanding future policy needs and future capabilities
- Data Delivery? Don’t, make data available in std GIS format.

Key Questions Today and Beyond

- How can we continue to build and improve in stakeholder engagement and relevance of CMS science?
- What are stakeholder needs for CM/MRV, and to what extent are they being met?
- What are the emerging lessons of success, and failure, in working stakeholders and what are proposed solutions?
- What are the next priority topics, timelines, and opportunities for CMS?